CLAIMS

We claim:

1. A system for modeling an elongated object, said elongated shape being located internal to a body, said system comprising:

a magnetic field generator generating a localized magnetic field;

a radio frequency (RF) energy source generating pulsed RF energy directed towards a body located within said localized magnetic field;

a receiver receiving magnetic energy responsive to pulsed RF energy;

a gradient analyzer analyzing and extracting gradient information from received magnetic resonance energy;

a shape modeler interactively forming a tubular model of an elongated object in said body and impressing said model with extracted gradient information; and

a display displaying said elongated object model.

2. A system as in claim 1, wherein the gradient analyzer comprises:

means for extracting the gradient of received magnetic resonance data;

means for computing the magnitude of said extracted gradient; and

means for extracting the gradient of said gradient magnitude.

3. A system as in claim 1 wherein said shape modeler comprises:

means for interactively defining an axis in said elongated object;

means for defining a reference circumferential direction about said elongated object;

means for defining radial lines extending outward from said axis; and

means for selectively merging radial lines intersecting with one another.

4. A system as in claim 3, wherein axis points are interactively provided to said axis defining means by a user, said system further comprising:

means for interpolating said axis from said provided axis points.

5. A system as in claim 4, wherein said interpolation means connects axis points using a b-spline.

6. A system as in claim 4, wherein the reference circumferential direction is defined as a function of axial position.

7. A system as in claim 4, wherein radial lines are defined extending outwards from said axis for all axial and circumferential positions.

8. A system as in claim 1, wherein said shape modeler comprises:

means for initializing all radial and circumferential positions of an initial model responsive to extracted gradient information, said gradient information representing image and smoothing forces at each radius; and

means for deforming tubular model vertices subject to said image and smoothing forces.

9. A system as in claim 8, wherein said body is a human body.

10. A system as in claim 9, wherein said elongated object is a blood vessel said display displaying a surface model of said blood vessel.

11. A system as in claim 10, wherein said blood vessel is the carotid artery.

12. A system as in claim 10, wherein said blood vessel is the renal artery.

13. A system as in claim 1, wherein said shape modeler comprises:

means for constructing a tubular coordinate system;

means for determining an initial shape of a surface mesh responsive to a gradient magnitude image in said tubular coordinate system; and

means for modifying said initial surface mesh shape responsive to the gradient of said gradient magnitude image within said tubular coordinate system.

14. A method of converting collected image data into a viewable image, said method comprising the steps of:

a) deriving image gradient information from collected image data;

b) defining a tubular model of an elongated object;

c) initializing vertices in said tubular model responsive to said derived gradient information; and

d) deforming vertices of said tubular model responsive to smoothing forces and said derived gradient information.

15. A method as in claim 14, wherein the image data is magnetic resonance image data and the step (a) of deriving said image gradient information comprises the steps of:

i) deriving the gradient of magnetic resonance image data;

ii) deriving the magnitude of said derived gradient; and

iii) deriving the gradient of said derived gradient magnitude.

16. A method as in claim 15, wherein the step (b) of defining said initial tubular model comprises the steps of:

i) defining an object axis;

ii) defining a reference circumferential direction about said object as a function of axial position;

iii) defining radial lines extending outwards from said defined object axis; and

iv) merging intersecting radial lines.

17. A method as in claim 16, wherein the step (iv) of defining said object axis comprises the steps of:

A) interactively defining object axis points; and

B) interpolating between object axis points.

18. A method as in claim 17, wherein said interpolation step (B) comprises using a b- spline to connect defined object axis points.

19. A method as in claim 15, wherein the step (b) of defining said initial tubular model comprises constructing a tubular coordinate system.

20. A method as in claim 19, wherein the step (c) of initializing vertices comprises determining an initial shape of a surface mesh of said tubular coordinate system responsive to a gradient magnitude image.

21. A method as in claim 20, wherein the step (d) of deforming vertex locations comprises modifying said initial surface mesh shape responsive to the gradient of said gradient magnitude image.

22. A method as in claim 14, wherein the tubular object is a blood vessel and the viewable image is a surface of said blood vessel.

23. A method as in claim 22, wherein the blood vessel is a carotid artery, displaying said viewable image indicating carotid artery stenosis.

24. A method as in claim 22, wherein the blood vessel is a renal artery, displaying said viewable image indicating renal artery stenosis.

25. A computer program product for reconstructing a 3D surface of a vessel, said computer program product comprising a computer usable medium having computer readable program code comprising:

computer readable program code means for deriving image gradient information;

computer readable program code means for defining a tubular coordinate system for an elongated object;

computer readable program code means for initializing vertices in said tubular coordinate system responsive to said derived gradient information; and

computer readable program code means for deforming vertex locations in said tubular coordinate system responsive to smoothing forces and said derived image gradient information, said deformed tubular vertices locating a 3D surface of a vessel.

26. A computer program product for reconstructing a vessel surface as in claim 25, wherein the image data is magnetic resonance imaging data and the computer readable program code means for deriving said gradient information comprises:

computer readable program code means for deriving the gradient of magnetic resonance data;

computer readable program code means for deriving the magnitude of said derived gradient; and

computer readable program code means for deriving the gradient of said derived gradient magnitude.

27. A computer program product for reconstructing a vessel surface as in claim 26, wherein the computer readable program means for defining said tubular coordinate system comprises:

computer readable program code means for defining an object axis;

computer readable program code means for defining a reference circumferential direction about said object as a function of axial position;

computer readable program code means for defining radial lines extending outwards from said defined object axis; and

computer readable program code means for merging intersecting radial lines.

28. A computer program product for reconstructing a vessel surface as in claim 27, wherein the computer readable program code means for defining said object axis comprises:

computer readable program code means for interactively defining object axis points; and

computer readable program code means for interpolating between object axis points.

29. A computer program product for reconstructing a vessel surface as in claim 28, wherein interpolation comprises:

computer readable program code means for using a b-spline to connect defined object axis points.

30. A computer program product for reconstructing a vessel surface as in claim 29 further comprising:

computer readable program code means for causing said vessel surface to be displayed.

31. A computer program product for reconstructing a vessel surface as in claim 30, wherein the vessel is a carotid artery, displaying said vessel surface indicating carotid artery stenosis.

32. A computer program product for reconstructing a vessel surface as in claim 30, wherein the vessel is a renal artery, displaying said vessel surface indicating renal artery stenosis.